DUPLICATE

METEOROLOGICAL OFFICE

# Forecasting Research

Forecasting Research Division
Technical Report No. 178

## Report on the Second Nimrod Trial

by

B W Golding

September 1995

Meteorological Office
London Road
Bracknell
Berkshire
RG12 2SZ
United Kingdom

ORGS UKMO F

National Meteorological Library
FitzRoy Road, Exeter, Devon. EX1 3PB

Forecasting Research
Technical Report No. 178

# Report on the Second Nimrod Trial

by

B W Golding

September 1995

Forecasting Research
Meteorological Office
London Road
Bracknell
Berkshire
RG12 2SZ
United Kingdom

© Crown Copyright 1995

This document has not been published. Permission to quote from it must be obtained from the Director of Forecasting Research at the above address.

# Report on the Second Nimrod Trial

Brian Golding, Project Manager

## Background

The first trial ran from 17 February to 14 March 1995 following a run-up period during January and early February. In this phase of the trial, subjective assessments were made of 9 actuals and 3 forecasts per day. Objective assessments were also made but were given little weight in deciding the outcome.

The original criterion for automation of FRONTIERS was that the results should be as good as the FRONTIERS results. The specific criteria laid down for the first trial did not take account of objective comparisons. The criterion for the actuals was that Nimrod should be 'better on average'. In terms of the assessment method outlined below, this was interpreted as: Nimrod should be significantly better more often that FRONTIERS is significantly better. For the forecasts, the criterion was that FRONTIERS forecasts should be significantly better on less than 10% of occasions (regardless of how often Nimrod forecasts were better).

During April to July, the NWP model forecasts were incorporated in the latter parts of the forecast, and quantitative values were estimated outside the radar area using a variational analysis of satellite, forecast and surface data. Minor changes were also made to the original components of the system, mainly to improve efficiency. The scope of the automatic verification was extended.

## Conduct of the second trial

The second trial started on 24 July but was restarted after two weeks following discovery and correction of a fault in the spurious echo removal. The trial was restarted on 5 August and was cosidered by the User Group on 5 September. This coincided with a change from dry to wet conditions and with discovery that subjective assessment of forecasts had been erroneosly using pure extrapolation forecasts rather than the merged forecasts. The trial was therefore extended to 13 September to obtain assessment in wet conditions and with the merged forecast output. The following revised specification of the trial was followed:-

"The working rainfall modules will be run in real time for a month. Nimrod and FRONTIERS analyses and forecasts will be assessed both objectively and subjectively.

### Reliability

The percentage of attempted runs which generated analyses and forecasts will be measured. Runs which were not attempted will be excluded if it can be shown that a call-out arrangement such as exists for FRONTIERS would have enabled the run to proceed.

### Objective assessment

The analyses will be assessed objectively by accumulating hourly totals for comparison with real time gauge reports from the radar calibration gauges, SREWs and automatic observing stations. The RMSF difference will be computed for all periods when a gauge observed at least 0.2mm of rain or the hourly accumulated Nimrod or FRONTIERS analyses exceeded 0.2mm. In the event of a 'miss' or a 'false alarm', the data source without any rain will be set to 0.1mm so as to give a minimum fractional error of 2.0. The RMSF score will be an acceptance criterion.

The forecasts will be objectively assessed for location & rate in comparison with the corresponding analyses over the area of reliable radar cover. Location will be assessed by thresholding at 0.125 mm/hr, then smoothing with a 25km half-width Gaussian and computing hit rate, false alarm rate & threat score. For rate, the RMSF error will be computed allowing a minimum fractional error of 2.0 for a 'miss' or 'false alarm' as described above. RMSF forecast accumulation errors will also be generated for Nimrod but will only be compared if suitable data can be obtained from FRONTIERS without disproportionate cost. The T+1,3,6 threat scores and RMSF scores will constitute acceptance criteria.

**Subjective assessment**

Subjective assessments will be performed by CFO G7 aviation forecasters on 3 forecast runs per day, chosen at random. Forecasts, depicted on a 6-up chart showing Nimrod & FRONTIERS forecasts for T+1,3,6, will be verified against their corresponding analyses, also depicted on a 6-up chart. The analyses will themselves be verified against synoptic & satellite information. The assessors will record the occasions when either Nimrod or FRONTIERS is significantly better. The level of significance should be such that a change to a CFO short period forecast would be made if Nimrod rather than FRONTIERS were in operational use. The net scores for the analyses and for T+1,3,6 will constitute acceptance criteria.

**Quality**

Analyses and forecasts should be produced on at least 95% of attempted runs.
The balance of the acceptance criteria should be neutral or in favour of Nimrod."

**Definition of scores**

hit rate = correct forecasts over threshold / actual occurrences over threshold
false alarm rate = spurious forecasts over threshold / forecasts over threshold
CSI / Threat score = correct forecasts over threshold / (actual occurrences + spurious forecasts)
RMSF = exp ( sqrt ( ln ( forecast / actual ) / number of comparisons) )

In this paper, a wider range of statistics will be presented than those required by the above criteria. In particular, the trial scores are set in the context of monthly results since the start of the first trial. In all tables, the better score of Nimrod & FRONTIERS is indicated by bold figures. The critical measures are brought together in the final section for ease of reference by the project board.

## Actuals

Method of objective assessment

Assessment was against hourly reporting raingauges: SREWs, automatic stations, and radar calibration gauges. 15min composite radar actuals were summed to give hourly accumulations: pixels were only included where at least 3 radar observations of the pixel were available in the hour. Due to the uncertainties resulting from a finite tip volume care was taken with comparisons of amounts less than 0.2mm. Two sets of statistics were generated. For the first set, it was required that both radar and gauge exceed 0.2mm hourly accumulation. For the second set, the locations where one estimate was less than 0.2mm were verified as if that estimate was at least 0.1mm. Three statistics were calculated: mean, RMS and RMSF.

Results

Statistics for cases where both radar & gauge observed at least 0.2mm

| Month | Number | | Mean | | RMS | | RMSF | |
|---|---|---|---|---|---|---|---|---|
| | F | N | F | N | F | N | F | N |
| Trial1 | | | 0.24 | **0.19** | 1.19 | **1.10** | 2.97 | **2.59** |
| Mar 17- | 1058 | 1133 | **0.20** | 0.28 | **0.93** | 3.24 | 2.48 | **2.61** |
| Apr | 2220 | 2219 | -0.13 | **0.12** | 1.50 | **0.84** | 2.50 | **2.36** |
| May | 2480 | 2456 | **0.16** | 0.28 | 1.06 | **1.02** | 2.41 | **2.40** |
| Jun | 1727 | 1511 | **0.05** | 0.34 | 1.12 | **1.03** | **2.31** | 2.35 |
| Jul | 2417 | 2153 | **0.32** | 0.45 | **1.83** | 1.91 | 2.71 | **2.69** |
| Aug | 700 | 516 | 0.05 | **-0.04** | **2.17** | 3.44 | **2.66** | 2.88 |
| Sep-13 | 3322 | 2909 | **0.63** | 0.88 | 2.39 | **1.90** | **2.62** | 2.74 |
| Trial2 | 3964 | 3376 | **0.54** | 0.74 | 2.25 | **2.09** | **2.62** | 2.75 |

Statistics for cases where either radar or gauge observed at least 0.2mm

| Month | Number | | Mean | | RMS | | RMSF | |
|---|---|---|---|---|---|---|---|---|
| | F | N | F | N | F | N | F | N |
| Mar 17- | 2560 | 2555 | 0.26 | **0.21** | 2.19 | 2.19 | 3.05 | **2.97** |
| Apr | 6127 | 6082 | **-0.07** | 0.16 | 1.47 | **1.28** | 3.40 | **3.35** |
| May | 6389 | 6229 | **0.13** | 0.19 | **0.92** | 1.02 | 3.38 | **3.26** |
| Jun | 5577 | 5365 | **0.16** | 0.32 | 1.76 | **1.32** | 3.56 | **3.48** |
| Jul | 6321 | 5930 | **0.27** | 0.41 | 2.40 | 2.40 | 4.13 | **4.10** |
| Aug | 2930 | 2768 | **0.32** | 0.39 | **3.92** | 4.14 | **4.05** | 4.22 |
| Sep-13 | 6491 | 6222 | **0.42** | 0.60 | 2.25 | **2.24** | **3.62** | 3.77 |
| Trial2 | 9253 | 8856 | **0.40** | 0.54 | **2.74** | 2.84 | **3.70** | 3.87 |

Method of subjective assessment

The first stage of assessment was to compare the FRONTIERS and Nimrod actuals. If there were significant differences, assessment was primarily against synoptic present weather reports, but continuity of the radar, satellite imagery, and experience with similar situations on FRONTIERS were also used. The full FRONTIERS area was assessed. Four scores were possible: No significant differences; Significant differences but neither better; Significant differences and FRONTIERS better; Significant differences and Nimrod better. Comments were recorded to justify the mark. Differences were regarded as significant if they would lead to a different "short period forecast" (a CFO product). A list of all cases in which a preferred forecast was recorded is given in the Annex.

Subjective Results

| | FRONTIERS better | Nimrod better |
|---|---|---|
| 5 August - 4 September | | |
| out of 182 comparisons | 21 | 12 |
| 5 September - 13 September | | |
| out of 51 comparisons | 2 | 1 |

Discussion

Despite the instruction to mark a preferred actual only when the difference was sufficient to cause a change in the issued forecast, the predominance of dry weather in August resulted in a tendency to mark on small differences in the distribution of rain at the lightest intensity level (0.125 - 0.25 mm/hr). In general, the radar cannot detect drizzle, and many of the markings in favour of FRONTIERS refer to drizzle situations where FRONTIERS left in the few pixels observed by the radar, whereas Nimrod removed them. Nimrod may be correct in determining that these are clutter echoes, but FRONTIERS is probably providing useful guidance in leaving them. Neither system correctly represented the extent of the drizzle area, although in some cases the rates probably did not exceed 0.125mm/hr. In September, the marks against Nimrod referred to underestimation of rain rate in North East England. It appears that the radar was under-reading, so that rates were more accurate before the removal of bright band contamination. Inclusion of the gauge adjustment scheme in Nimrod will remove this problem.

## Forecasts

Methods of objective assessment

Assessment was against the corresponding actual, within the Nimrod 'area of radar coverage' and excluding pixels which had non-quantitative rain in either the forecast or actual. For rain location, hit rate, false alarm rate and threat score were computed after both forecast and actual had been thresholded at 0.125mm/hr and at 10mm/hr, both at full pixel resolution and with the resulting detection field smoothed with a 25km half width Gaussian to remove 'speckle' at the pixel scale. In order to avoid favouring forecasts with excessively widespread rain, the smoothing algorithm preserves the number of wet pixels. Scores were computed excluding comparisons of worthless forecasts, by terminating comparison of a forecast sequence once both methods had a CSI less than 0.2, this being approximately the expected value for a random forecast. This also yields an assessment of the percentage of forecasts at each lead time for which at least one of the systems produced 'useful' results. The number of forecasts at each lead time, differing by at least 0.1 in CSI was also computed.

For rain rate, 15km average values of forecast and actual were compared where both or either exceed 0.125mm/hr and 10mm/hr. In the case where either exceeds the threshold, the lower value is set to at least half the threshold. The number of successful comparisons, the RMS error and the RMSF error were calculated for each set of comparisons.

For rain accumulation, 15km average values of forecast and actual hourly accumulations were compared over the area of England for which FRONTIERS actuals are computed, when both or either exceeded 0.2mm. In the case where either exceeds the threshold, the lower value is set to at least half the threshold. The number of successful comparisons, the RMS error and the RMSF error were calculated for each set of comparisons.

Results

Percentage of forecasts in which at least one method achieved CSI>0.2

| Month | T+1 | T+2 | T+3 | T+4 | T+5 | T+6 |
|---|---|---|---|---|---|---|
| Trial1 | 89 | 72 | 49 | 32 | 19 | 12 |
| Feb | 92 | 70 | 42 | 24 | 10 | 5 |
| Mar | 82 | 66 | 46 | 30 | 20 | 13 |
| Apr | 63 | 48 | 32 | 21 | 16 | 11 |
| May | 81 | 70 | 57 | 46 | 38 | 30 |
| Jun | 51 | 35 | 25 | 18 | 15 | 13 |
| Jul | 80 | 65 | 52 | 43 | 35 | 30 |
| Aug | 63 | 44 | 30 | 20 | 15 | 10 |
| Sep-13 | 98 | 96 | 89 | 81 | 77 | 73 |
| Trial2 | 72 | 58 | 47 | 39 | 35 | 30 |

The percentage of useful forecasts drops rapidly with forecast time. The rate of fall decreased significantly from May when merged Nimrod forecasts were included in the comparison. The low June & August results reflect the very small number of wet days in those months.

Rain location, smoothed, 0.125 threshold, cases for which one method has CSI>0.2:

| HR | T+1 | | T+2 | | T+3 | | T+4 | | T+5 | | T+6 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | F | N | F | N | F | N | F | N | F | N | F | N |
| Trial1 | 63 | **65** | 47 | 47 | **38** | 37 | **34** | 32 | **34** | 30 | **34** | 28 |
| Feb | 61 | **63** | 44 | **47** | 34 | **37** | 28 | **34** | 28 | **34** | 26 | **30** |
| Mar | 63 | **64** | **47** | 46 | **41** | 37 | **38** | 32 | **36** | 28 | **35** | 26 |
| Apr | 68 | **69** | **53** | 52 | **45** | 43 | **40** | 38 | 34 | 34 | 28 | **31** |
| May | 72 | **73** | 58 | **61** | 49 | **53** | 43 | **49** | 38 | **45** | 34 | **43** |
| Jun | 68 | **72** | 55 | **65** | 46 | **64** | 39 | **63** | 34 | **64** | 28 | **66** |
| Jul | 69 | **72** | 52 | **62** | 43 | **59** | 35 | **58** | 29 | **59** | 24 | **60** |
| Aug | 61 | **67** | 46 | **56** | 39 | **52** | 32 | **51** | 26 | **49** | 21 | **48** |
| Sep-13 | 78 | **80** | 62 | **72** | 52 | **70** | 44 | **69** | 38 | **68** | 33 | **68** |
| Trial2 | 73 | **77** | 58 | **69** | 49 | **67** | 42 | **66** | 36 | **66** | 31 | **67** |

| FAR | T+1 | | T+2 | | T+3 | | T+4 | | T+5 | | T+6 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Trial1 | 33 | **32** | 44 | **43** | 48 | 48 | 51 | 51 | **50** | 52 | **48** | 52 |
| Feb | 34 | **32** | 45 | **43** | 48 | **47** | 54 | **53** | **58** | 61 | **50** | 61 |
| Mar | 35 | **32** | 45 | 45 | **48** | 50 | **49** | 52 | **47** | 54 | **47** | 55 |
| Apr | 31 | **29** | 42 | **41** | 45 | 45 | **46** | 48 | **49** | 50 | **52** | 53 |
| May | 28 | **26** | 38 | **37** | 44 | **42** | 47 | **45** | 49 | **47** | 51 | **49** |
| Jun | **29** | 36 | **38** | 47 | **43** | 54 | **47** | 58 | **49** | 61 | **51** | 63 |
| Jul | 33 | **32** | **45** | 46 | **51** | 54 | **55** | 57 | **58** | 60 | 61 | **60** |
| Aug | 38 | **33** | 49 | **48** | **55** | 58 | **61** | 63 | **65** | 68 | **67** | 69 |
| Sep-13 | 25 | **24** | **36** | 40 | **43** | 49 | **48** | 55 | **52** | 59 | **56** | 61 |
| Trial2 | 28 | **26** | **39** | 42 | **45** | 51 | **50** | 57 | **54** | 60 | **57** | 62 |

| CSI | T+1 | | T+2 | | T+3 | | T+4 | | T+5 | | T+6 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | F | N | F | N | F | N | F | N | F | N | F | N |
| Trial1 | 48 | **50** | 34 | **35** | 28 | 28 | 25 | 25 | **25** | 23 | **26** | 22 |
| Feb | 46 | **49** | 32 | **35** | 26 | **28** | 21 | **24** | 20 | **22** | 21 | 21 |
| Mar | 47 | **49** | 34 | 34 | **30** | 27 | **28** | 24 | **27** | 21 | **27** | 20 |
| Apr | 52 | **54** | 38 | 38 | **33** | 32 | **30** | 28 | 25 | 25 | 22 | **23** |
| May | 57 | **58** | 43 | **45** | 36 | **38** | 31 | **35** | 28 | **32** | 25 | **31** |
| Jun | **54** | 51 | 41 | 41 | 34 | **37** | 29 | **34** | 25 | **32** | 22 | **31** |
| Jul | 52 | **54** | 37 | **41** | 29 | **35** | 24 | **33** | 21 | **31** | 17 | **31** |
| Aug | 44 | **50** | 32 | **37** | 26 | **30** | 22 | **27** | 18 | **24** | 15 | **23** |
| Sep-13 | 62 | **64** | 46 | **49** | 37 | **41** | 31 | **37** | 27 | **34** | 23 | **33** |
| Trial2 | 57 | **60** | 43 | **46** | 35 | **39** | 30 | **36** | 25 | **33** | 22 | **32** |

Percentage of forecasts for which one method's threat score exceeded the other by at least 0.1

| % better | T+1 | | T+2 | | T+3 | | T+4 | | T+5 | | T+6 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | F | N | F | N | F | N | F | N | F | N | F | N |
| Trial1 | 6 | **14** | 9 | **15** | 15 | **17** | 18 | **21** | **25** | 18 | **33** | 17 |
| Feb | 7 | **16** | 7 | **17** | 12 | **19** | 18 | **23** | 16 | **19** | **33** | 20 |
| Mar | 8 | **17** | 14 | **15** | **24** | 17 | **28** | 23 | **38** | 21 | **42** | 20 |
| Apr | 12 | **21** | 17 | 17 | **22** | 15 | **29** | 18 | **28** | 20 | **26** | 22 |
| May | **12** | 10 | 10 | **16** | 12 | **19** | 12 | **22** | 10 | **26** | 9 | **31** |
| Jun | **31** | 19 | 24 | **25** | 23 | **34** | 19 | **42** | 14 | **51** | 11 | **63** |
| Jul | 18 | 18 | 16 | **26** | 16 | **33** | 15 | **40** | 14 | **50** | 14 | **61** |
| Aug | 28 | 28 | 26 | **31** | 21 | **31** | 19 | **35** | 19 | **39** | 17 | **42** |
| Sep-13 | **13** | 12 | 13 | **14** | 12 | **18** | 13 | **29** | 13 | **37** | 11 | **47** |
| Trial2 | 22 | 22 | 17 | **23** | 14 | **24** | 14 | **32** | 14 | **38** | 11 | **46** |

Rain location, unsmoothed, 10.0mm/hr threshold

| CSI | T+1 | | T+2 | | T+3 | | T+4 | | T+5 | | T+6 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | F | N | F | N | F | N | F | N | F | N | F | N |
| Jul | 3 | **4** | 0 | **1** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Aug | 3 | 3 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Sep-13 | **4** | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Trial2 | 2 | **3** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

Rain rate - 15km averages - where both forecast & actual exceed 0.125 mm/hr:

| RMSF | T+1 | | T+2 | | T+3 | | T+4 | | T+5 | | T+6 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | F | N | F | N | F | N | F | N | F | N | F | N |
| Trial1 | **2.74** | 2.83 | **3.14** | 3.18 | 3.34 | **3.30** | 3.42 | **3.40** | 3.39 | **3.37** | 3.45 | **3.34** |
| Feb | 2.90 | **2.82** | 3.43 | **3.16** | 3.66 | **3.25** | 3.69 | **3.30** | 3.32 | **3.21** | **3.07** | 3.14 |
| Mar | **2.62** | 2.79 | **2.93** | 3.12 | **3.14** | 3.24 | 3.38 | **3.34** | **3.30** | 3.31 | 3.34 | **3.27** |
| Apr | 2.64 | **2.46** | 3.21 | **2.82** | 3.95 | **3.04** | 3.79 | **3.12** | 4.01 | **3.16** | 4.27 | **3.25** |
| May | 2.46 | **2.30** | 2.88 | **2.62** | 3.17 | **2.78** | 3.36 | **2.87** | 3.41 | **2.94** | 3.49 | **2.95** |
| Jun | 2.55 | **2.27** | 2.88 | **2.48** | 3.15 | **2.58** | 3.35 | **2.58** | 3.29 | **2.59** | 3.33 | **2.55** |
| Jul | 3.07 | **2.81** | 3.66 | **3.23** | 3.93 | **3.40** | 3.96 | **3.47** | 3.94 | **3.52** | 3.93 | **3.46** |
| Aug | 3.19 | **3.01** | 3.67 | **3.57** | 3.89 | **3.82** | 4.00 | **3.86** | 4.15 | **3.90** | 4.24 | **3.92** |
| Sep-13 | 2.65 | **2.35** | 3.14 | **2.73** | 3.35 | **2.89** | 3.50 | **2.96** | 3.60 | **3.00** | 3.62 | **3.05** |
| Trial2 | 2.72 | **2.45** | 3.19 | **2.85** | 3.37 | **3.01** | 3.53 | **3.05** | 3.63 | **3.07** | 3.65 | **3.11** |

Rain rate - 15km averages - where either forecast or actual exceeds 0.125 mm/hr:

| RMSF | T+1 | | T+2 | | T+3 | | T+4 | | T+5 | | T+6 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | F | N | F | N | F | N | F | N | F | N | F | N |
| May | 4.23 | **3.90** | 5.45 | **5.02** | 6.07 | **5.63** | 6.51 | **6.04** | 6.86 | **6.31** | 7.13 | **6.53** |
| Jun | 4.38 | **3.80** | 5.56 | **4.57** | 6.21 | **4.77** | 6.71 | **4.87** | 7.01 | **4.91** | 7.22 | **4.92** |
| Jul | 5.52 | **4.84** | 7.52 | **6.05** | 8.52 | **6.45** | 9.25 | **6.56** | 9.62 | **6.63** | 9.94 | **6.70** |
| Aug | 6.05 | **5.19** | 7.73 | **6.67** | 8.69 | **7.17** | 9.15 | **7.32** | 9.49 | **7.30** | 9.90 | **7.26** |
| Sep-13 | 4.59 | **3.65** | 6.21 | **4.67** | 7.11 | **5.07** | 7.72 | **5.29** | 8.14 | **5.52** | 8.49 | **5.79** |
| Trial2 | 4.93 | **3.94** | 6.50 | **5.01** | 7.35 | **5.42** | 7.91 | **5.66** | 8.26 | **5.81** | 8.61 | **5.99** |

Rain rate - 15km averages - where both forecast & actual exceed 10.0 mm/hr

| RMSF | T+1 | | T+2 | | T+3 | | T+4 | | T+5 | | T+6 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | F | N | F | N | F | N | F | N | F | N | F | N |
| Jun | - | **2.24** | - | - | - | - | - | - | - | - | - | - |
| Jul | 1.93 | **1.89** | **1.31** | 1.66 | 1.42 | **1.40** | **1.46** | 1.56 | **1.37** | - | **1.93** | - |
| Aug | **1.48** | 1.92 | **1.38** | 1.66 | **1.27** | 1.66 | **1.81** | - | - | - | **1.71** | - |
| Sep-13 | 1.48 | **1.14** | **1.28** | - | - | - | - | - | - | - | - | - |
| Trial2 | **1.48** | 1.97 | **1.38** | 1.66 | - | - | - | - | - | - | - | - |

Rain rate - 15km averages - where either forecast or actual exceeds 10.0 mm/hr

| RMSF | T+1 | | T+2 | | T+3 | | T+4 | | T+5 | | T+6 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | F | N | F | N | F | N | F | N | F | N | F | N |
| Jun | **3.49** | 3.92 | **3.30** | 3.98 | **3.30** | 3.84 | **3.30** | 4.25 | **3.17** | 4.04 | **3.17** | 4.03 |
| Jul | 3.28 | **3.00** | 3.24 | **3.13** | 3.29 | **3.23** | 3.21 | **3.20** | **3.21** | 3.29 | **3.22** | 3.27 |
| Aug | **2.94** | 3.02 | **3.07** | 3.25 | **3.09** | 3.33 | **3.10** | 3.40 | **3.14** | 3.25 | **3.10** | 3.22 |
| Sep-13 | 2.59 | **2.38** | 2.82 | **2.40** | 2.89 | **2.47** | 2.95 | **2.48** | 2.91 | **2.48** | 2.82 | **2.48** |
| Trial2 | **2.80** | 3.11 | **2.90** | 3.39 | **2.89** | 3.51 | **2.96** | 3.53 | **2.94** | 3.32 | **2.88** | 3.33 |

Hourly rain accumulation - 15km averages - where both forecast & actual exceed 0.2mm

| RMSF | T+1 | | T+2 | | T+3 | | T+4 | | T+5 | | T+6 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | F | N | F | N | F | N | F | N | F | N | F | N |
| Jul | 2.00 | **1.99** | 2.80 | **2.56** | 3.11 | **2.84** | 3.27 | **2.96** | 3.25 | **2.98** | 3.27 | **3.11** |
| Aug | 1.91 | **1.82** | **2.62** | 2.63 | **2.94** | 2.95 | 3.10 | **3.07** | 3.17 | **2.88** | 3.17 | **2.81** |
| Sep-13 | 1.79 | **1.66** | 2.51 | **2.22** | 2.79 | **2.44** | 2.91 | **2.51** | 3.00 | **2.56** | 3.02 | **2.56** |
| Trial2 | 1.81 | **1.69** | 2.52 | **2.29** | 2.80 | **2.51** | 2.92 | **2.57** | 3.02 | **2.58** | 3.03 | **2.58** |

Hourly rain accumulation - 15km averages - where either forecast or actual exceeds 0.2mm

| RMSF | T+1 | | T+2 | | T+3 | | T+4 | | T+5 | | T+6 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | F | N | F | N | F | N | F | N | F | N | F | N |
| Jul | **2.99** | 3.01 | 4.67 | **4.46** | 5.59 | **5.20** | 6.26 | **5.57** | 6.55 | **5.74** | 6.85 | **5.87** |
| Aug | 2.82 | **2.53** | 4.39 | **4.00** | 5.25 | **4.72** | 5.73 | **5.17** | 6.07 | **5.34** | 6.27 | **5.26** |
| Sep-13 | 2.34 | **2.12** | 3.92 | **3.37** | 4.88 | **3.97** | 5.45 | **4.23** | 5.80 | **4.41** | 6.05 | **4.55** |
| Trial2 | 2.43 | **2.19** | 3.98 | **3.46** | 4.90 | **4.07** | 5.45 | **4.37** | 5.79 | **4.56** | 6.05 | **4.65** |

Subjective Results

| Number marked better | T+1 | | T+3 | | T+6 | |
|---|---|---|---|---|---|---|
| 5 August - 4 September | F | N | F | N | F | N |
| number of cases | 63 | | 62 | | 60 | |
| | **11** | 6 | **11** | 7 | **11** | 9 |
| 5 - 13 September | | | | | | |
| out of 18 cases | 1 | **3** | 1 | **8** | 2 | **9** |

**Discussion**

The low percentage of useful forecasts in August reflects the fact that in situations with isolated pockets of light rain or drizzle, the observations are inconsistent from hour to hour and the overlap between forecast & observed is likely to be small. Whereas the subjective assessment gives all cases equal weight, the objective assessment effectively weights according to the number of wet pixels. It is not, therefore, surprising that the results differ. Also, the subjective assessments for August are based on the Nimrod advection forecast rather than the merged forecast and so do not represent the quality of the current system. The benefits of merging with the model are the main reason for the subjective preference for Nimrod in September. The objective assessments also indicate that in the more significant rain situations, Nimrod gives a better distribution and better intensity.

## Reliability

The reliability of the Nimrod forecasting system is estimated below from the percentage of possible forecasts assessed. This is a pessimistic estimate since it does not allow for failures of the assessment programme itself.

| % assessed | T+1 | T+2 | T+3 | T+4 | T+5 | T+6 |
|---|---|---|---|---|---|---|
| Trial1 | 94 | 94 | 94 | 93 | 93 | 92 |
| Feb | 87 | 87 | 86 | 86 | 86 | 85 |
| Mar | 94 | 93 | 93 | 93 | 93 | 92 |
| Apr | 98 | 98 | 97 | 97 | 97 | 97 |
| May | 90 | 89 | 88 | 87 | 85 | 84 |
| Jun | 96 | 96 | 96 | 96 | 96 | 96 |
| Jul | 100 | 100 | 100 | 100 | 100 | 100 |
| Aug | 99 | 99 | 99 | 99 | 99 | 99 |
| Sep | 100 | 100 | 100 | 100 | 100 | 100 |
| Trial2 | 100 | 100 | 100 | 100 | 100 | 100 |

## Timeliness

Current timings give an average availability for Nimrod of T+0:12 for the actual (against T+0:20 for FRONTIERS) and T+0:20 for the forecast (against T+0:33 for FRONTIERS).

| % available | 0:14 | 0:16 | 0:18 | 0:20 | 0:22 | 0:24 | 0:26 | 0:28 | 0:30 |
|---|---|---|---|---|---|---|---|---|---|
| Feb | 0 | 6 | 24 | 51 | 70 | 79 | 85 | 89 | 93 |
| Mar | 0 | 5 | 27 | 52 | 73 | 80 | 86 | 91 | 93 |
| Apr | 0 | 16 | 54 | 88 | 97 | 98 | 99 | 99 | 99 |
| May | 0 | 15 | 66 | 92 | 99 | 99 | 99 | 99 | 100 |
| Jun | 0 | 20 | 80 | 97 | 98 | 99 | 99 | 99 | 99 |
| Jul | 0 | 5 | 30 | 66 | 89 | 96 | 98 | 99 | 99 |
| Aug | 0 | 16 | 53 | 81 | 95 | 98 | 99 | 99 | 99 |
| Sep | 0 | 1 | 10 | 34 | 74 | 89 | 95 | 97 | 98 |

## Summary Results of Acceptance Criteria

**Reliability**

% completed - 99.6%

**Actuals**

Objective

RMSF FRONTIERS - **3.70** Nimrod - 3.87

Subjective (5 August - 13 September, 233 cases)

% better FRONTIERS - **10%** Nimrod - 6%

| **Forecasts** | **T+1** | | **T+3** | | **T+6** | |
|---|---|---|---|---|---|---|
| Objective | F | N | F | N | F | N |
| CSI>0.125mm/hr | 57 | **60** | 35 | **39** | 22 | **32** |
| RMSF rate | 4.93 | **3.94** | 7.35 | **5.42** | 8.61 | **5.99** |
| RMSF accum | 2.43 | **2.19** | 4.90 | **4.07** | 6.05 | **4.65** |
| Subjective (5 - 13 September, 18 cases) | | | | | | |
| % better | 6% | **17%** | 6% | **44%** | 11% | **50%** |

## Recommendation

The results for the August trial period were affected by the lack of rain and by the presentational error in the Nimrod forecasts. The lack of rain resulted in the subjective assessment marking at a low level of difference between the systems. It also lowered the reliability of the objective scores. The extension into September coincided with a particularly wet period in which the benefits of the merged Nimrod forecast were apparent. As shown in the summary section, the resulting scores show a clear preference for Nimrod forecasts in the objective scores and in the subjective scores for the September period, but a preference for FRONTIERS in the assessment of the actuals.

Results from the objective assessment are available for the whole period since the first trial and are able to put the performance during the trials into perspective. These suggest that the performance during the first trial was anomalous and that had the trial been completed at the end of February, it would probably have been considered successful. Nevertheless, the weakness in the later part of the forecast identified in that trial was corrected during May by the use of model forecasts, and the resulting improvement is clear in the forecast statistics. The results in August, as in June, show generally low skill in dry conditions, the scores dominated by isolated patches of rain and clutter. Following the problems with shower removal in July, the anaprop step in Nimrod is now tuned to leave rain in any situation where significant rates are possible. There remain weaknesses in the system which have resulted in light rain being removed and light clutter being retained. These weaknesses do not constitute major errors and the results should be considered adequate, subject to further improvement. The gauge adjustment scheme, already approved, will improve the performance of the radar correction scheme in conditions of significant rain. Neither system is designed to predict light rain and drizzle that is largely unseen by radar. Improvements in the prediction of such conditions can be built into Nimrod but should not be considered part of the requirement to replace FRONTIERS.

**I recommend that :**

(i) The current Nimrod system be accepted as providing an adequate replacement for the current FRONTIERS rainfall analysis & forecasting service and that steps be taken to transfer the operational responsibility for providing that service.

(ii) The project manager be tasked with providing an upgrade to the spurious echo removal algorithm, for implementation by April 1996, after the normal project review & acceptance procedures.

## Acknowledgements

The automated FRONTIERS system was developed by B.Conway, G.Ryall, N.Thomas, R.Brown, M.Kitchen, A.Davies, W.Hand, S.Higginson and implemented by D.Harrison, D.Stone, P.Newcomb. The subjective assessments were carried out by CFO forecasters on the General Aviation G2 position for trial 1, and the Senior Aviation position for trial 2.

## References

The Nimrod plan was originally stated in the Project Initiation Document, agreed in June 1993.
The current update is version 4.1, agreed in May 1995.
The plan for development of the automation algorithms (stage 2) was agreed in September 1993 and completed in January 1994.
The plan for implementation of the automated FRONTIERS (stage 3) was agreed in September 1993.
These documents are available from the project manager on request.
An overview of the project, periodically updated, is also available from the project manager.
Development to December 1994 was reported in Golding,B.W., 1995, "Rainfall - analysis and short range prediction", in *Hydrological Uses of Weather Radar*, Ed. K.A.Tilford. British Hydrological Society, Occasional Paper No.5.

**Annex: Summary of cases marked A or B.**

| Case | Date/time | N | Marks | | | CSI | | RMSF Rate | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Act | F/c | F | N | | F | N | |
| 1F | 06/1700 | 1100 | D | B | 53 | 67 | | 5.5 | 4.1 | F/c: N agreed SFLOCs, NE France |
| | 06/1900 | 1000 | D | B | 32 | 59 | | 7.1 | 4.8 | F/c: ditto |
| | 06/2200 | 800 | D | B | 10 | 16 | | 5.2 | 5.2 | F/c: ditto |
| 2F | 10/0100 | 0 | C | A? | - | / | | / | / | F/c: N rain wrong NW corner - no truth |
| | 10/0300 | 0 | C | A? | / | / | | / | / | F/c: ditto |
| | 10/0600 | 0 | - | A? | - | / | | - | / | F/c: ditto |
| 3F | 13/1300 | 100 | D | A | 28 | 19 | | 3.1 | 3.6 | F/c: F better showers Scotland |
| | 13/1500 | 200 | D | A? | 0 | 0 | | 3.8 | 3.9 | F/c: ditto |
| | 13/1800 | 100 | D | B | 0 | 0 | | 3.6 | 4.8 | F/c: N fewer showers Scotland |
| 4F | 13/1430 | 300 | D | A | 4 | 11 | | 3.2 | 4.3 | F/c: F better showers Scotland |
| | 13/1630 | 200 | D | C | 0 | 0 | | 3.6 | 4.0 | |
| | 13/1930 | 100 | D | C | 0 | 0 | | 3.8 | 4.7 | |
| 5F | 13/1700 | 200 | D | C | 52 | 9 | | 3.0 | 3.0 | |
| | 13/1900 | 200 | D | A? | 6 | 0 | | 5.0 | 3.6 | F/c: F better timing across I.Sea |
| 6A | 14/1400 | 100 | A?D | | / | 0 | | / | 8.0 | Act: N left clutter Grampians |
| | 14/1600 | 100 | A?D | | / | 0 | | / | 14 | Act: ditto |
| | 14/1900 | 0 | D | D | / | / | | / | / | |
| 7F | 14/1600 | 100 | D!A? | | / | 51 | | / | 8.4 | F/c: N left clutter Grampians |
| | 14/1800 | 0 | D | A? | / | 0 | | / | 2.8 | F/c: ditto |
| | 14/2100 | 0 | D | A? | / | / | | / | / | F/c: ditto |
| 8 | 15/0500 | 100 | A | A | / | 0 | | / | 7.8 | Act: N left clutter Grampians |
| | 15/0700 | 100 | B | B | 0 | 0 | | 9.1 | 4.7 | Act: F left clutter |
| | 15/1000 | 0 | B | B | 0 | 0 | | 8.8 | 5.4 | Act: ditto |
| 9A | 15/1730 | 200 | D | D | 25 | 5 | | 6.6 | 4.1 | |
| | 15/1930 | 0 | B?D | | 2 | 0 | | 6.4 | 2.9 | Act: no ground truth but even N OTT?? |
| | 15/2230 | 0 | D | D | 0 | / | | 7.1 | / | |
| 10 | 16/0700 | 0 | A | A | / | / | | / | 9.5 | Act+F/c: N spurious precip E. N.Sea |
| | 16/0900 | 0 | D | A | / | / | | / | / | F/c: ditto (no cloud) |
| | 16/1200 | 0 | D | A | / | 0 | | / | 2.7 | F/c: ditto |
| 11 | 16/1900 | 0 | D | A | / | / | | / | 2.3 | Act: N spurious rain Irish Sea |
| | 16/2100 | 0 | B | A | / | 0 | | / | 5.7 | Act: ditto, F/c: N reasonable |
| | 17/0000 | 0 | B | A | / | / | | / | 5.2 | Act: ", F/c: N good NW, wrong S.N.Sea |
| 12 | 16/2130 | 0 | B | B | / | 0 | | / | 17 | Act: precip obs at Faeroes |
| | 16/2330 | 0 | B | D | / | 0 | | / | 20 | Act: N good NW, wrong S.N.Sea |
| | 17/0230 | 0 | B | D | / | 0 | | / | 9.6 | - |
| 13F | 17/2130 | 100 | D | D | / | 0 | | / | 6.1 | |
| | 17/2330 | 100 | D | D | - | 0 | | - | 4.4 | |
| | 18/0230 | 0 | D | A | / | 0 | | / | 7.9 | F/c: N Spurious precip N. N.Sea |
| 14F | 18/0730 | 0 | D | B? | / | 19 | | / | 3.8 | F/c: N rain E.Scotland |
| | 18/0930 | 0 | D | B? | / | 0 | | / | 4.6 | F/c: ditto |
| | 18/1230 | 100 | D | B? | 0 | 0 | | 5.0 | 4.6 | F/c: ditto |
| 15F | 20/1300 | 0 | D | C | 22 | 0 | | 65 | 83 | |
| | 20/1500 | 200 | D | C | 0 | 0 | | 13 | 28 | |
| | 20/1800 | 100 | D | B? | 0 | 0 | | 6.4 | 7.1 | F/c: N thunderstorms France |
| 16 | 20/2000 | 0 | B | B | - | 0 | | - | 7.9 | Act/F/c: N continental showers good |
| | 20/2200 | 0 | B | B | / | 0 | | 57 | 9.3 | Act/F/c: ditto |
| | 21/0100 | 0 | B | B | - | 0 | | - | 12 | Act/F/c: ditto |
| 17F | 21/0630 | 100 | D | C | 1 | 0 | | 4.8 | 4.5 | |
| | 21/0830 | 100 | D | A | 8 | 0 | | 5.6 | 3.6 | F/c: F rain nr Hebrides |
| | 21/1130 | 0 | D | A | 0 | 0 | | 4.6 | 3.4 | F/c: ditto |
| 18A | 21/1830 | 0 | C | C | 13 | / | | 4.1 | 3.8 | |
| | 21/2030 | 0 | A | C | 47 | 0 | | 5.9 | 6.4 | Act: F left rain/dz NW Scotland |
| | 21/2330 | 0 | A | C | 0 | 0 | | 5.9 | 65 | Act: ditto |
| 19 | 22/0130 | 0 | A | A | 57 | 26 | | 3.7 | 8.5 | Act+F/c: F more rain NW Scotland |
| | 22/0330 | 100 | A | A | 0 | 0 | | 5.1 | 3.7 | Act+F/c: ditto |
| | 22/0630 | 300 | D | C | 4 | 3 | | 4.8 | 3.2 | |
| 20F | 22/0900 | 100 | D | C | 35 | 12 | | 4.2 | 4.3 | |
| | 22/1100 | 100 | D | C | 0 | 0 | | 7.2 | 2.7 | |
| | 22/1400 | 300 | D | A | 0 | 0 | | 4.2 | 3.6 | F/c: both bad, F better showers E Scot |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 21 | 23/0400 | 2000 | - A | - | 50 | 5.4 | 7.0 | F/c: F has showers, N.Ireland |
| | 23/0600 | 2000 | A A | 53 | 34 | 6.8 | 5.7 | Act+f/c: F has showers N.Ireland |
| | 23/0900 | 2100 | D A | 34 | 21 | 6.7 | 5.2 | F/c: F showers N.Ire + better S.Eng |
| 22 | 23/0730 | 2000 | D D | 53 | 68 | 4.9 | 4.2 | |
| | 23/0930 | 1900 | A D | 26 | 36 | 7.0 | 5.3 | Act: F better showers N.Ireland |
| | 23/1230 | 1900 | A B | 8 | 17 | 8.7 | 7.1 | Act: N spurious SW, F/c: N better Eng.Chan. |
| 23 | 24/0600 | 3500 | D D | 53 | 68 | 6.0 | 3.4 | |
| | 24/0800 | 3400 | D B? | 10 | 51 | 8.5 | 4.5 | F/c: N more rain Wales |
| | 24/1100 | 1100 | A C | 0 | 14 | 7.0 | 6.6 | Act: F more rain N.Wales/ NW Eng |
| 24F | 24/1630 | 400 | D A | 21 | 14 | 5.1 | 5.6 | - |
| | 24/1830 | 500 | D A | 7 | 12 | 5.9 | 7.0 | - |
| 25 | 25/0000 | 1100 | A A | 27 | 48 | 4.8 | 6.0 | Act+f/c: F more rain S.Scotland |
| | 25/0200 | 600 | A C | 7 | 15 | 5.4 | 7.0 | Act: ditto |
| | 25/0500 | 100 | A C | 0 | 0 | 4.4 | 5.4 | Act: ditto |
| 26 | 25/0700 | 0 | A A | 1 | 0 | 4.3 | 3.7 | Act: showers S.Scot, F/c: rain E.Eng/NWScot |
| | 25/0900 | 0 | A C | 0 | 0 | 4.4 | 2.4 | Act: rain Wales/Wash |
| | 25/1200 | 0 | A A | 0 | / | 3.0 | / | Act: rain NEScot,NI,SWEng, F/c:rain Scot |
| 27F | 27/2130 | 300 | D D | 49 | 22 | 5.1 | 4.6 | |
| | 27/2330 | 100 | D B | 12 | 0 | 5.2 | 4.9 | F/c: N less showers SE Eng |
| | 28/0230 | 100 | D B | 0 | 0 | 5.5 | 4.8 | F?c: ditto |
| 28F | 29/0030 | 500 | C A | 15 | 31 | 5.8 | 3.2 | F/c: both poor, F better |
| | 29/0230 | 600 | C A | 20 | 10 | 6.1 | 3.4 | F/c: ditto |
| | 29/0530 | 800 | C C | 0 | 10 | 8.4 | 3.2 | |
| 29 | 29/1000 | 100 | A B | 11 | 61 | 7.3 | 3.7 | Act: rain CEng, F/c: F excessive rain Scot |
| | 29/1200 | 0 | A B | 0 | 0 | 11 | 3.4 | Act: rain C.Eng/N.E.Wales: F/c: ditto |
| | 29/1500 | 0 | D B | 0 | 0 | 12 | 2.6 | F/c ditto |
| 30A | 29/1530 | 0 | A C | 0 | 0 | 8.3 | 2.9 | Act: F more echoes in dz |
| | 29/1730 | 100 | C C | 0 | 0 | 4.1 | 3.2 | |
| | 29/2030 | 100 | C - | - | 0 | - | 5.7 | |
| 31A | 29/2330 | 300 | D D | 69 | 55 | 5.2 | 3.4 | |
| | 30/0130 | 100 | D C | 5 | 12 | 6.8 | 6.8 | |
| | 30/0430 | 0 | B C | 0 | 0 | 6.7 | 4.1 | Act: F spurous rain Midlands |
| 32F | 30/0200 | 100 | D D | 0 | 6 | 5.6 | 5.9 | |
| | 30/0400 | 0 | D A | 0 | 0 | 5.3 | 3.6 | F/c: rain E.Scotland |
| | 30/0700 | 0 | D A | 0 | 0 | 4.8 | 2.5 | F/c: ditto |
| 33F | 01/0430 | 0 | D D | 0 | 0 | 15 | 4.7 | |
| | 01/0630 | 100 | - D | / | 0 | - | 3.7 | |
| | 01/0930 | 200 | D A | 0 | 0 | 6.8 | 5.0 | F/c: F better NW Scotland |
| 34F | 01/0900 | 200 | D D | 8 | 43 | 6.4 | 3.1 | |
| | 01/1100 | 200 | D D | 0 | 0 | 4.9 | 3.5 | |
| | 01/1400 | 500 | D A | 0 | 0 | 9.2 | 5.1 | F/c: F better NW Scotland, both weak E.Eng |
| 35F | 06/0730 | 300 | D B | 39 | 26 | 3.3 | 3.6 | F/c: N advected rain into SW |
| | 06/0930 | 1400 | D B | 0 | 42 | 16 | 6.0 | F/c: ditto |
| | 06/1130 | 3100 | D B | 0 | 56 | 15 | 5.7 | F/c: ditto but N overdoes N.Sea |
| 36F | 06/1530 | 4400 | D D | 76 | 69 | 4.0 | 3.5 | |
| | 06/1730 | 4500 | D B | 59 | 52 | 5.6 | 4.5 | F/c: F lost rain S.Ireland |
| | 06/2030 | 4500 | D B | 41 | 41 | 8.2 | 5.0 | F/c: F ditto + weakened Wales/C.Eng |
| 37F | 06/1700 | 4400 | D D | 71 | 75 | 3.8 | 3.9 | |
| | 06/1900 | 4400 | D B | 53 | 56 | 5.9 | 4.2 | F/c: F weakened band esp. in W |
| | 06/2200 | 5100 | D B | 36 | 38 | 8.4 | 5.2 | F/c: ditto |
| 38F | 07/0430 | 5400 | D D | 52 | 64 | 5.9 | 4.0 | |
| | 07/0630 | 4200 | D D | 11 | 32 | 8.3 | 5.5 | |
| | 07/0930 | 5500 | D B | 11 | 33 | 8.5 | 6.0 | F/c: F deficient E.Eng |
| 39F | 08/1030 | 6000 | D D | 70 | 69 | 4.6 | 4.0 | |
| | 08/1230 | 6100 | D D | 43 | 44 | 7.3 | 5.5 | |
| | 08/1530 | 7400 | D A | 21 | 24 | 7.6 | 5.8 | F/c: N too far E, NE Eng |
| 40 | 11/0300 | 3700 | A A | 72 | 68 | 3.9 | 3.6 | Act+f/c: F heavier NE Eng |
| | 11/0500 | 3100 | C B | 32 | 31 | 7.4 | 5.8 | F/c: F too heavy NE Eng |
| | 11/0800 | 2700 | C B | 6 | 18 | 11 | 6.0 | F/c: neither good but F clearly worse |
| 41 | 11/0500 | 3100 | C C | 55 | 62 | 4.4 | 3.4 | |
| | 11/0700 | 2800 | A B | 21 | 22 | 7.3 | 5.1 | Act: F heavier NE Eng, F/c: N moved better |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 11/1000 | 2600 | D B | 6 | 23 | 9.1 | 5.6 | F/c: ditto |
| 42F | 11/0800 | 2700 | D B | 56 | 57 | 4.4 | 3.5 | F/c: F too heavy E.Eng |
| | 11/1000 | 2600 | D B | 23 | 31 | 7.1 | 4.9 | F/c: N cleared rain better E.Eng |
| | 11/1300 | 4100 | D B | 12 | 37 | 8.8 | 5.4 | F/c: ditto |
| 43F | 12/1130 | 1200 | D D | 40 | 28 | 4.8 | 4.9 | |
| | 12/1330 | 1500 | D A | 16 | 8 | 7.0 | 6.5 | F/c: F better shwr bands centred Wales |
| | 12/1630 | 2100 | D A | 12 | 10 | 7.6 | 5.7 | F/c: ditto |
| 44F | 12/1730 | 1900 | D C | 51 | 51 | 4.8 | 4.0 | |
| | 12/1930 | 1200 | - B? | - | 8 | - | 5.7 | |
| | 12/2230 | 800 | D C | 0 | 0 | 7.5 | 5.3 | |
| 45A | 13/1100 | 500 | D D | 65 | 37 | 4.3 | 3.4 | |
| | 13/1300 | 600 | D D | 23 | 32 | 6.7 | 4.8 | |
| | 13/1600 | 800 | B D | 22 | 21 | 6.2 | 5.9 | Act: N Better SW Ireland |
| 46F | 13/1600 | 800 | D B | 57 | 46 | 4.0 | 4.3 | F/c: N Better SW Ireland |
| | 13/1800 | 2100 | D B | 13 | 18 | 11 | 9.0 | F/c: ditto |
| | 13/2100 | 3200 | D B | 3 | 22 | 11 | 8.1 | F/c: ditto |